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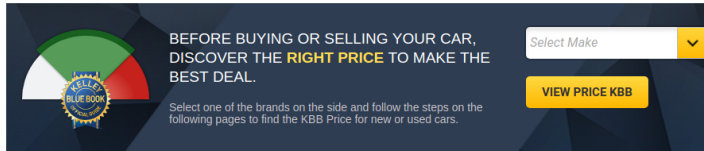
## Toyota has a long way ahead before it can sell a flex-fuel hybrid

04-04-2018 17h50 by KBB - Gustavo Henrique Ruffo

Prototype presented last March 19th is the first step towards what promises to be very beneficial to those looking for sustainable fuel economy



On March 19, Toyota introduced in Brazil a prototype based on the Prius that may not have called any attention elsewhere or locally, but that may represent a significant change of perspectives. Not only for the pioneer manufacturer regarding hybrids, but for ethanol itself. Widely used in Brazilian cars since the 1970's, it may become a common solution in other countries and one of the world's cleanest transportation alternatives. This is because ethanol does not worsen the greenhouse effect, since it does not release new carbon dioxide to the atmosphere. It simply returns the gas sugarcane took out of it to grow, due to photosynthesis. And purely electric cars still can be used in countries that use coal or fossil fuels to generate electricity. But there is still a lot of road to go, literally, before the flex-fuel hybrid is a real alternative, one that can be bought at a dealership.



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"The prototype that went to Brasilia, which I drove, has about 4,500 km on the clock. We have another one that has traveled a bit farther than this, but we are still in the beginning of development", said Edson Orikassa, product engineering manager at Toyota and president of the AEA (Brazilian Association of Automotive Engineering). "This means that we do not have consumer data, for example. We are still adjusting the calibration of the system. In other words, we have adopted some parameters, we have tested them and changed them to some others that may be better after some time. Anyway, I am able to tell you that we have the goal of having a fuel consumption equal to what we have today with the petrol model."

The development of a flex-fuel hybrid, for Toyota, addresses a number of strategic issues. The first one is internal: the Environmental Challenge 2050, in which the company has committed to meet 6 challenges, including reducing CO2 emissions from its cars by 90% by 2050. A flex-fuel hybrid would help a lot accomplish such mission. The second are Brazilian industrial policies for automobiles. "We started thinking about a flex-fuel hybrid in 2015. With the Inovar-Auto and Rota 2030, the government also promotes technological innovation." The prototype has come in the wake of these programs, and the government's ability to stimulate technology is important", says Orikassa. Even if not entirely new, hybrid technology with a new component, ethanol use, would surely fit what the Brazilian government wants to stimulate.




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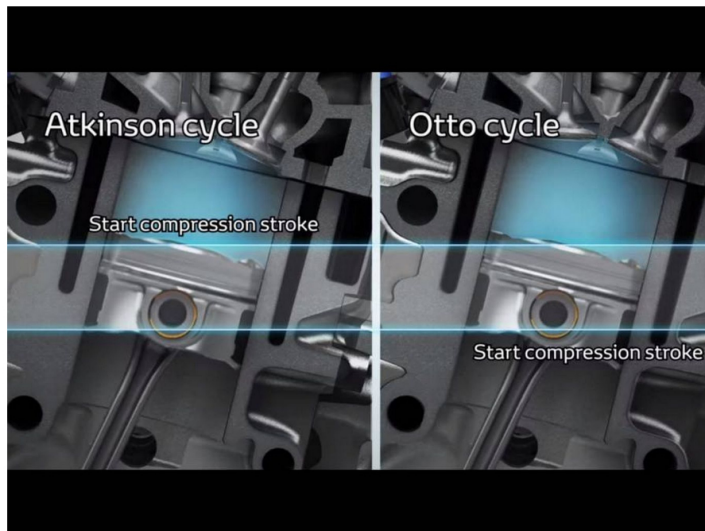


According to the Brazilian fuel consumption body, called Conpet Veicular, the current **Prius** is capable of achieving 5.29 l/100 km in the city and 5.88 l/100 km on the road with petrol. Higher consumption on the road than in the city is a phenomenon typical of hybrid models, which can use the electric motor more often in urban driving. And they can, in some cases, even move with only the power of the batteries in some stretches. On highways, the combustion engine is activated all the time and the electric motor only assists in moments of greater consumption, such as accelerations and braking.

#### The difficulties

Any common flex-fuel car, running on ethanol, would have great difficulty in matching the fuel consumption provided by a petrol-only car. For a very simple reason: the petroleum derivative has a higher calorific value than ethanol. While petrol normally has 8.325 Kcal/l, hydrous ethanol has 5.380 Kcal/l, [according to Novacana.com](#). In other words, only 65% of energy. For the same amount of fuel, in the same tank, a lower proportion of force, something we have **already shown that does not necessarily allow the 70% price calculation in order to know which is the best fuel to put on the tank of a flex-fuel car: petrol or ethanol**. This is because some flex engines favour the use of petrol and others focus on ethanol.

With that chemical difference in mind, how could **Toyota's** flex hybrid achieve, with ethanol, a fuel consumption at least similar to the one offered by its current petrol-only hybrid? First of all, with more assistance of the electric motor and the battery that define it as a hybrid, but also with elements that **Toyota** has not yet detailed and that make all the difference: its knowledge of ethanol, [the Dynamic Force engine](#) and the [Atkinson cycle](#).



With regard to the performances of the electric motor and of its batteries, they could be essential in solving two of the biggest obstacles to the development of a flex-fuel hybrid. The first is the so-called cold phase, which requires heating the ethanol so that the engine starts without an auxiliary tank of petrol. The second is running short distances, which prevent the engine from reaching its optimum operating temperature. In both situations, ethanol does not burn in the most efficient way, which causes it to drain down the cylinders walls and contaminate the lubricant. [Pointed out by Quatro Rodas magazine](#), these problems can be approached in several ways. Among them is the development of a lubricant that stands these conditions or the use of stronger batteries, which allow ethanol to be heated several times in a row.

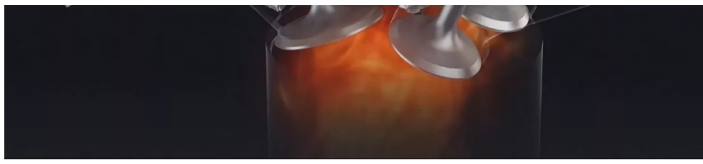
Another option would be a larger-capacity battery pack, which would allow longer runs with electricity only, firing the combustion engine only on longer routes. Or a thermal management that ensures the engine reaches its optimum operating temperature faster. Or a mode of operation that would run the combustion engine longer in order to charge the batteries, but these are solutions that would probably run counter to cost efficiency. "As ethanol is a reality in Brazil, and there is a chance of it being adopted in the rest of Latin America, the development of a flex-fuel hybrid could serve a whole region. For hybrid technology to take off in Brazil, it has to have the flex-fuel technology", says Orikassa.

Other countries are also encouraging the use of ethanol in Europe. Besides Sweden, France also has ethanol fuel stations and even services of engine conversions from petrol-only to flex-fuel regular cars and hybrids, such as the one offered by FlexFuel Energy Development. With conversions from 500 € up to 1,300 €, the company promises a saving of around 500 € every year for the converted cars, since ethanol costs much less than petrol in France. A flex-fuel hybrid sold straight from a Toyota dealership would probably be a good idea in Europe as well.

The knowledge of flex-fuel engines is evidenced by the fact that **Toyota** develops excellent mills of the type, with good specific power and which are more powerful with ethanol. They take full advantage of the greater resistance to detonation of the vegetable fuel. Its 4-cylinder 2.0, for example, has a compression ratio of 12:1, which already denotes a greater attention to ethanol. Even so, the flex-fuel engines of the brand maintain an average of 69% efficiency with ethanol compared to the use of petrol. It would not be difficult for **Toyota** to adopt a more aggressive compression ratio in order to increase engine efficiency with ethanol.

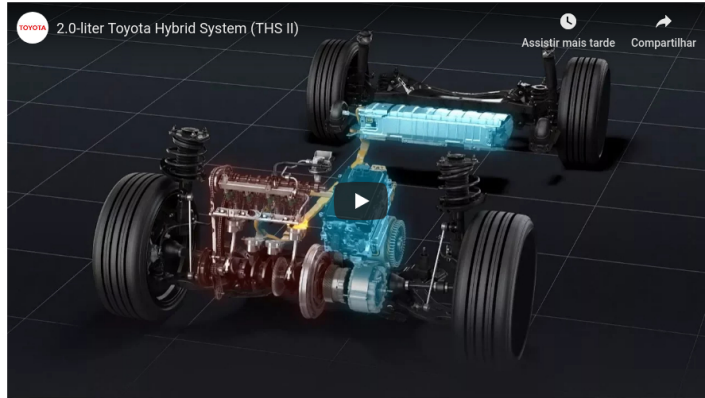
The brand does not reveal its plans, but it is very likely that prototypes under test in Brazil will already use the family of Dynamic Force engines, with an energy efficiency of 40%. They use a direct injection system that works in conjunction with indirect injection. At low and medium loads, the two work together to improve the rate of air and fuel intake. At high loads, only the direct injection is used, which increases the compression and the speed of admission. The compression ratio of Dynamic Force engines is also higher, as befits an ethanol engine. Their state-of-the-art thermal management should help with cold starts and warm up the flex-fuel engine over short distances. Exactly the more pressing problems that the flex-fuel hybrid has to overcome. Isn't it extraordinary how things fit together?





Finally, the Atkinson cycle causes the compression stroke of the fuel to be shorter than that of the piston expansion. This is done by controlling the valves. The intake manifolds remain open longer, which returns part of the air-fuel mixture to the intake manifold while the piston rises. And minimizes pumping losses. In other words, it makes the engine more efficient. Ordinary motors, purely Otto, have exactly the same stroke in these two "times," which makes the engine work harder to compress the mixture. It is noteworthy that **Toyota's** flex-fuel hybrid prototype is the first vehicle with a full-time Atkinson cycle for ethanol.

Another factor that contributes to the development of the flex-fuel hybrids is that the new Dynamic Force engine will come with the THS II, the second generation of **Toyota's** hybrid system. It has a number of enhancements, such as a more compact and efficient PCU (Power Control Unit) and smaller and more efficient motor and generator, with their own auxiliary transmission system. The battery pack, also smaller and lighter, can have the same power as the previous one, with more cells (180, against 168). The new THS II interrupts all systems when the car is still, which uses less energy. It also has a more efficient brake regeneration system. **Toyota** also promises stronger and more linear accelerations.

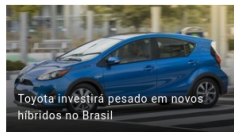


Although the prototype of the future flex-fuel hybrid is in a **Prius** body, it is more likely to appear on the next-generation **Corolla**. Both the Prius and the future **Corolla** use the **TNGA platform**. And the Dynamic Force engine and the THS II have already been shown in the new **Toyota Auris, also called Corolla IM in the USA**. The reason for this is simple: **Toyota** wants to make hybrids more popular in Brazil. What better way to do it than to offer the technology at the **Corolla**, one of the brand's best-sellers in the country? Even because one of the car's derivatives, the Altis, is sold at close value to the **Prius**, but cheaper. Nothing more logical than the sedan to also offer a hybrid version. Flexible in fuel.

In theory, we could already have a flex-fuel hybrid derivative at the launch of the new generation of **Corolla**, scheduled for 2019, but everything depends on the pace that the brand will be able to impose to the development of technology. It also depends on a series of political decisions in Brazil, but at least two promises must be met: environmental friendliness, with a clean car, and the highest fuel economy an ethanol-powered car has ever been able to offer.

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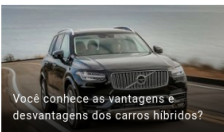
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